IBM 701

International Business Machines Type 701 Electronic Data Processing Machine

MANUFACTURER

International Business Machines Corporation

Picture by International Business Machines Corporation

APPLICATIONS

Manufacturer

Commercial, scientific and engineering data processing.

Government Sample

U. S. Naval Ordnance Test Station, China Lake

Scientific data processing.

Industrial Sample

Douglas Aircraft Company, Incorporated

Aircraft engineering.

United Aircraft Corporation

The United Aircraft Corporation provides a central computing facility located at the Research Department for the solution of engineering and research problems. It services the three UAC Divisions: Pratt and Whitney Aircraft, Sikorsky Aircraft, and Hamilton Standard which are engaged in the design and manufacture of aircraft engines, helicopters, propellers and other aircraft equipment.

Computing equipment includes: two IBM Type 704, one IBM Type 701, three IBM Card-Programmed Calculators, and three Burroughs Type E101 calculators. Additional features include a Universal Tape Selector on each IBM Type 704 calculator. This device was designed by UAC and permits electrical switching at the console of magnetic tape units to main frame or off-line input/output components.

NUMERICAL SYSTEM

Manufacturer

Internal number system	Binary
Binary digits per word	18 or 36 per data word
Binary digits per instruction	18
Instructions per word	2
Instructions decoded	32
Instructions used	32
Arithmetic system	Fixed point
Instruction type	One address
Number range	$-(2^{35}-1) \leqslant n \leqslant (2^{35}-1)$

Picture by University of California Radiation Laboratory

Timing	Synchronous
Operation	Sequential and partially concurrent

Government Sample
U. S. Naval Ordnance Test Station, China Lake
Each half or whole word is uniquely addressable.

ARITHMETIC UNIT

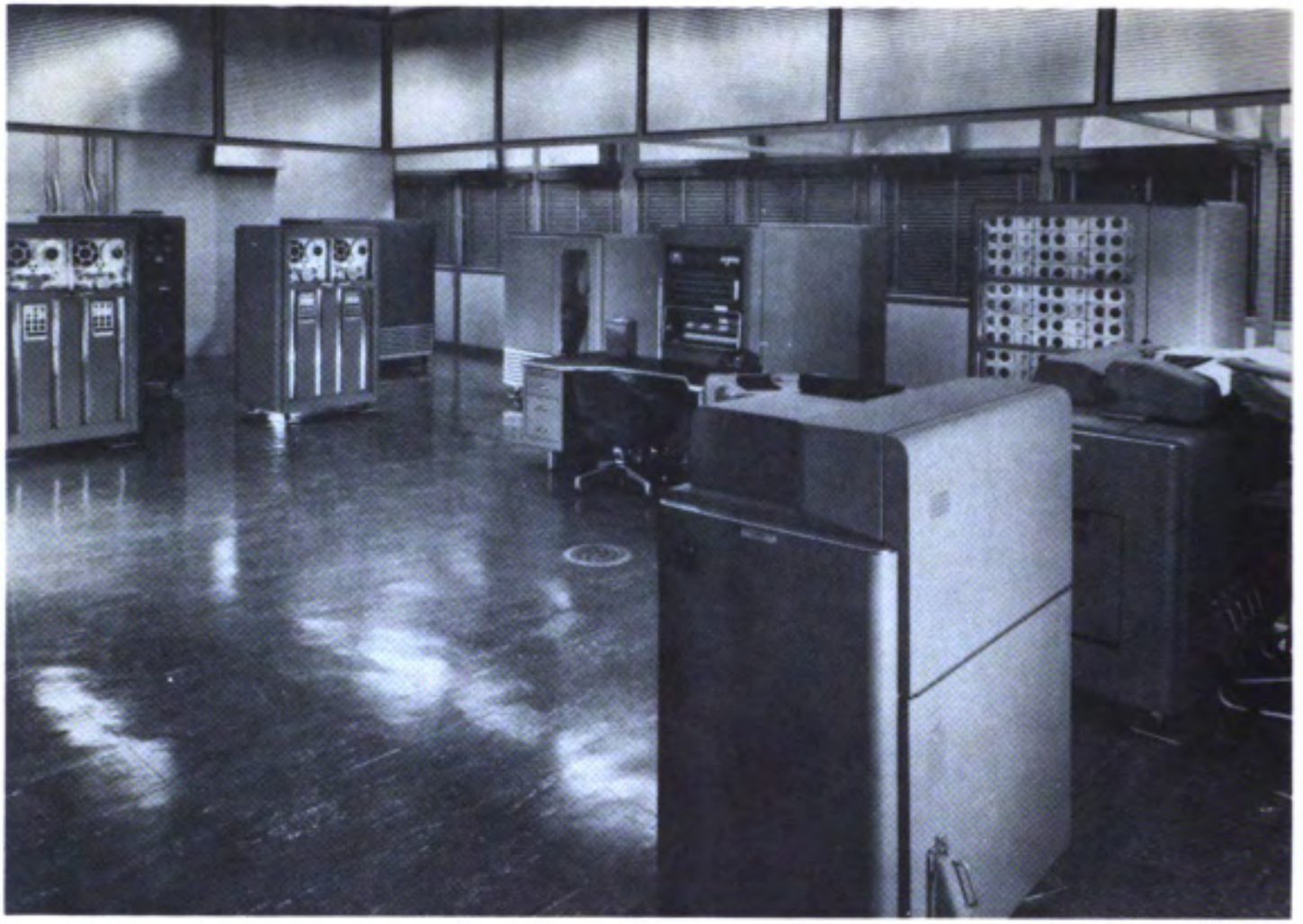
	Microsec
Add time (exclud. stor. access)	60 or 36
Mult time (exclud. stor. access)	444
Div time (exclud. stor. access)	444
Construction	Vacuum tubes or magnetic cores
Basic pulse repetition rate	1 Mc/sec
Arithmetic mode	Parallel

Operation time of 60 microseconds is for CRT.
Operation time of 36 microseconds is for Magnetic Core.
Times given above include access to instruction.

STORAGE

Media	Words	Microsec Access
Magnetic Core	4,096	12
Cathode Ray Tube	2,048 or 4,096	12
Magnetic Drum	8,192 or 16,384	50,000

Magnetic drum access time is average to first word of group. All times given below are in microseconds. Computation time is available depending on programming technique. Subsequent word time is 1,280 per word of which 1,000 can be used for computation.
Magnetic Tape - 300,000 binary words per tape. (Up to 4 magnetic tapes) Type 726. (2 magnetic tapes per frame. Pulse packing 100 groups per inch.)
The time to accelerate magnetic tape to write status (75 inches per sec.) is 10,000 of which 6,000 is available for further computations. Time to write subsequent words is 792 each, of which 700 is available for further computation. Time to read subsequent words is 792 of which 540 is available for computation. Magnetic tape (1 magnetic tape per frame). Pulse packing 200 groups per inch. -- 900,000 binary words per tape. 540,000 binary coded decimal and alpha-numeric words per tape. Up to 10 tapes.
Time to accelerate magnetic tape to write status (75 inches/sec.) from standstill is 10,000 of which 7,000 are available for further computation. Time to write subsequent words is 400 each of which 336 is available for further computation. Time to accelerate magnetic tape to read status (75 inches/sec.) from standstill is 10,000 of which 3,000 are available for further computation. Time to read subsequent words is 400 each of which 288 are available for computation. Magnetic tape unit can rewind 2,400 feet of tape in 1.2 minutes.



Picture by General Motors Corporation

Either magnetic core or cathode ray tube storage is used. Time is in microsec.

Government Sample
U. S. Naval Ordnance Test Station, China Lake
System has 4,096 words of magnetic core storage, 8,192 words of magnetic drum and 900,000 words on each tape unit. Access times are 12, 50,000 (random) and 10,000 (from standstill) microseconds, respectively. Ten type 727 tape units are utilized.

INPUT

Media	Speed
Punched Card Reader	150 cards/min
Magnetic Tape Type 726	12,500 dec dig/sec
Magnetic Tape Type 727	15,000 char/sec or 25,000 dec dig/sec
Cards to Magnetic Tape	250 cards/min

The punched card reader operates such that 177 millisec are available between cards for computation. The Type 727 Magnetic Tape Unit operates at the above rates for alphanumeric characters and decimal digits respectively. For the card to magnetic tape converter the cards must be in decimal alphanumeric code. The magnetic tape is written in binary coded decimal alphanumeric code and simultaneously checked.

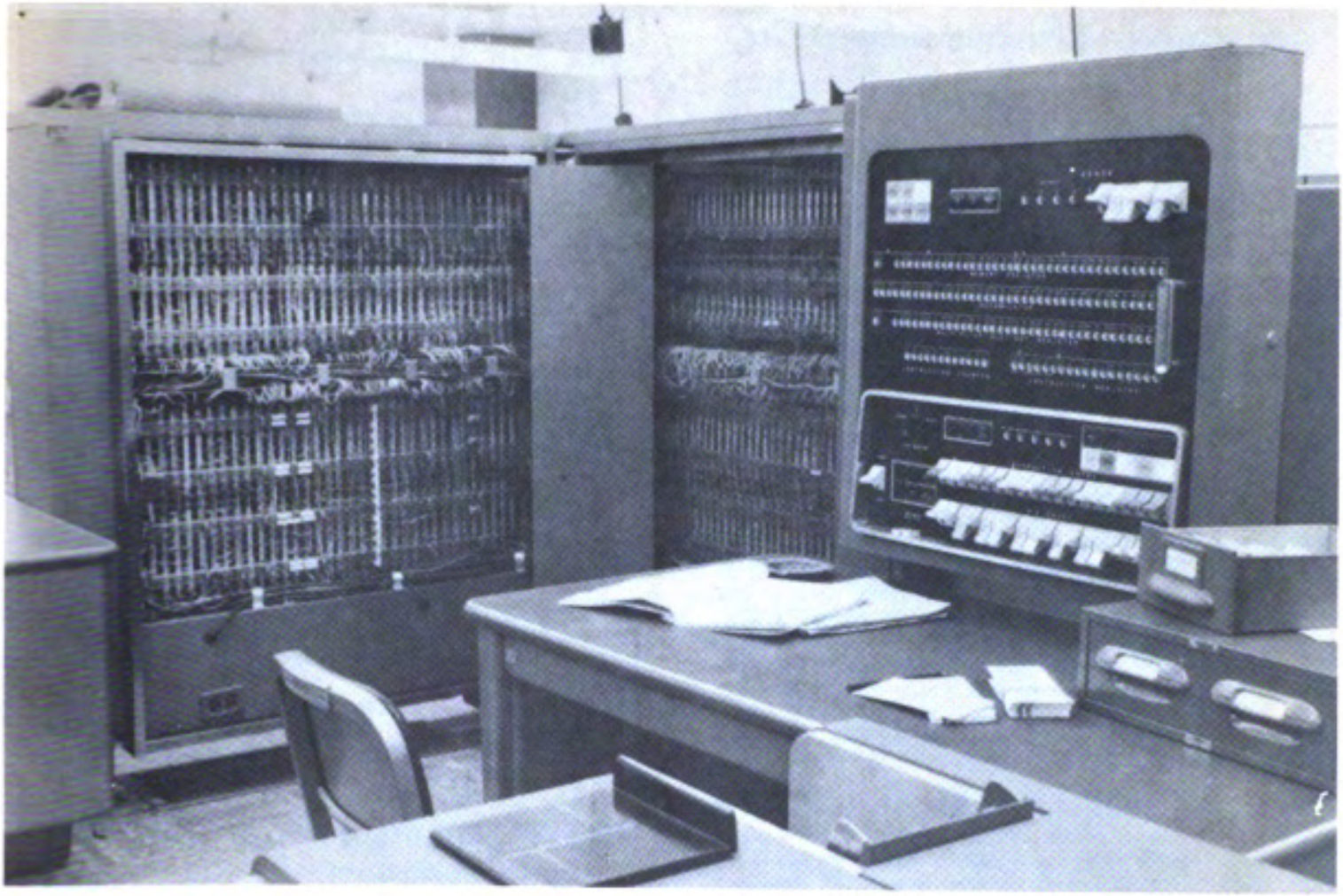
Government Sample

Government Sample
U. S. Naval Ordnance Test Station, China Lake
Card reader, magnetic tape and card to tape converter are utilized. Information on tape written in binary coded decimal system of notation. The card to tape unit is peripheral equipment.

OUTPUT

Media	Speed
Punched Card	100 cards/min
Line Printer	150 lines/min
Cathode Ray Tube Display	8,300 data points/sec
Magnetic Tape Type 726	12,500 equiv dec dig/sec
Magnetic Tape Type 727	
Magnetic Tape to Card	100 cards/min
Magnetic Tape to Line Printer	150 lines/min

The punched card recorder may operate on binary or decimal cards. Binary cards contain 24 words. 342,000 microseconds are available for computing while punching one card.
The printer is of the wheel type. It is connected to the computer through the analytical and logical unit. 322,000 microseconds are available for computation between successive lines.
The CRT Display Unit consists of two display tubes: a 7-inch tube for photographic purposes and a 21-inch tube for visual displays.
Magnetic Tape to Card Unit operates with Type 727



Picture by Lockheed Aircraft Corporation

Tape Unit only. Alphanumeric punched characters are automatically internally checked by unit. Magnetic Tape to Line Printer Unit operates with the Type 727 Tape Unit only. The printer is of the wheel type, 150 lines/min, 120 alphanumeric char/line. 1,000 lines/min operation is possible, with 60 char/line (wire matrix printer).

Government Sample
U. S. Naval Ordnance Test Station, China Lake

System utilizes the following equipment:

Medium	Speed
Card Punch	100 cards/min at 72 columns/card
Printer	150 lines/min at 72 char/line
Magnetic Tape	2,500 words/sec
Tape to Printer	150 lines/min at 120 char/line
Tape to Cards	100 cards/min at 80 columns/card

The two peripheral converters accept binary coded decimal information on magnetic tape.

CIRCUIT ELEMENTS ENTIRE SYSTEM

Tubes	4,000
Tube types	35
Crystal diodes	12,800

Government Sample
U. S. Naval Ordnance Test Station, China Lake

In addition to above system also consists 147,456 magnetic cores and 26 separate cabinets.

CHECKING FEATURES

Magnetic Tape (Type 726) - vertical parity bit check for each tape column.

Magnetic Tape (Type 727) - Horizontal and vertical parity bit check for each tape row and column.

Line Printer - Echo checking for each printed character.

Card to Magnetic Tape - checks magnetic tape as Type 726. Checks card.

Tape to Printer (Type 727 magnetic tape only) - horizontal and vertical parity bit check for each tape row and column. Echo checking for each printed character.

Tape to card - horizontal and vertical parity bit check for each tape row and column.

Arithmetic and Logical Unit - overflow in accumulator. Two extra positions are on left side of accumulator so that overflow is not lost. Divide check. Dividend Divisor

Government Sample
U. S. Naval Ordnance Test Station, China Lake

Above checks are utilized. Echo checking must be wired in on Line Printer board. Instructions used to test condition of tape check light and overflow indicator.

POWER, SPACE AND WEIGHT

	Weight (lbs)	KVA
Main Frame	2,850	34.4
Punched Card Recorder	720	0.7
Line Printer (Wheel Type)	2,795	3.1
Magnetic Drum	1,480	9.9
Cathode Ray Tube Frame	2,445	11.8
Power Frame No. 1	2,810	5.8
Power Frame No. 2	2,750	5.8
Power Distribution Unit	1,230	1.2
Magnetic Tape Unit (726)	1,270	4.6
Magnetic Tape Control Unit	1,636	6.0
Punched Card Reader	530	0.7

Space Occupied:
Machine including two 726 frames - 3,000 sq. ft.
Customer engineering requirements - 400 sq. ft.
Air conditioning - 40 tons

Government Sample
U. S. Naval Ordnance Test Station, Chins Lake
System requires 80 KW, 136 KVA, 1,404 cu. ft., 1,400 sq. ft. The system area is 44 by 27 ft. and weighs 40,050 lbs., including peripheral equipment.
The above power, space and weight does not include supporting machines such as key punches, reproducers, and sorters. This equipment would add 8 KVA and 8,000 lbs.

Industrial Sample
Douglas Aircraft Company, Incorporated
Total Engineering Building is air conditioned.

PRODUCTION RECORD

Produced	19
Operating	16
Delivery time	Special

COST, PRICE AND RENTAL RATE

Rental rates are subject to change.

System I.	Monthly Charges
Electronic Analytical Control Unit	$8,100
Electrostatic Storage Unit (2,048 words)	2,600
Punched Card Reader	200
Alphabetic Printer (wheel type)	800
Punched Card Recorder	200
2 Type 726 Magnetic Tape Readers & Recorders (2 magnetic tapes per frame) for a total of 4 magnetic tapes)	1,700
Magnetic Drum Reader and Recorder	1,400
Tape Control Unit	2,500

System II.	
Electronic Analytical Control Unit	$8,100
Electrostatic Storage Unit (2,048) words	2,600
Punched Card Reader	200
Alphabetic Printer (wheel type)	800
Punched Card Recorder	200
4 Type 727 Magnetic Tapes (one magnetic tape per frame)	2,200
Magnetic Drum Reader and Recorder	1,400
Tape Control Unit	2,500

This system is compatible through common language tape units with the 650, 702, 704, 705 and the additional equipment listed below.

Either of the above systems may replace the 2,048 words of cathode ray tube storage with 4,096 words of magnetic core storage.

Tape to Card Punch and Card Punch Control Unit (punches 100 cards/minute)	$1,050
Magnetic Tape to Line Printer (wheel type) and Printer Control Unit	1,800
Magnetic Tape to Card Reader and Card Reader Control Unit (reads 250 cards/minute)	$2,400
Cathode Ray Tube Output Recorder	2,850

Government Sample
U. S. Naval Ordnance Test Station, China Lake
Rental rate for basic system is $21,500/month.
Rental rate for additional equipment $8,550/month.

PERSONNEL REQUIREMENTS

Manufacturer
Maintained by IBM.

Government Sample
U. S. Naval Ordnance Test Station, China Lake
For three 8-hour shifts 6 engineers and 19 technician-operators are utilized. Approximately 9 mathematics aides, 10 mathematicians and 20 to 25 persons from outside the branch, program and run their own problems.

Industrial Sample
Douglas Aircraft Company
For three 8-hour shifts, 6 engineers, 4 technician-operators, and 33 programmers are utilized.

United Aircraft Company
Two IBM Type 704 and one IBM Type 701 Computers are operated on a 24 hour, six-day week. Three CPC's and three Burroughs E101's are operated on an 8 hour, five-day week.
The Laboratory is staffed by 51 analysts, 11 operators, and 24 aides. Non-computing personnel operate CPC s and E101's. Non-computing personnel also program for all calculators.

RELIABILITY AND OPERATING EXPERIENCE

Government Sample
Atomic Energy Commission, University of California Radiation Laboratory
System accepted 26 April 1954; the average error-free running period is 6.2 hours; good time is 3,032 hours and the attempted to run time is 3,587 hours, resulting in an operating ratio of 0.85; the average error free running time is calculated by dividing the total hours less the total Scheduled Maintenance less Total unscheduled Maintenance less the Loss Time Claimed by Operator all by the Total number of Hours of Down and Lost Time reported. The above figures are given for the period January 1955 to June 1955 when operating 24 hours/day.

U. S. Naval Ordnance Test Station, China Lake
A core storage was installed recently.

Industrial Sample
Douglas Aircraft Company

Average error-free running period	4 hours plus
Good time	4,068.1
Attempted to run time	4,351.8
Operating ratio (Good/Attempted to run)	0.934

Figures based on period 1 January 1956 to 30 September 1956

Power on 5,104.6 hours from 1 January 1956 to 30 September 1956

Preventive maintenance	13.6%
Non-scheduled maintenance	6.7%
Douglas machine time	79.9%

General Motors Corporation
System accepted in April 1954; average error free running period is 4.5 hours derived from the records for 1 month; good time of 1,067 hours and attempted to run time of 1,154 hours yielding an operating ratio of 0.92 for a four month period.

Lockheed Aircraft Corporation

Systems accepted on 14 May 1953 and 15 July 1954; average error free running periods of 3-4 hours on one and 1-1/2 hours on the other; good time of 74.4% and 80% where good time is considered as actual production and the remaining 25.6% and 20% respectively, consists of preventive maintenance, breakdown, machine re-work and idle time. The average error-free running period is reduced considerably when tapes are used frequently. Short runs are made wherever possible (1-5 hours), but the same program is run for as long as 12 hours and would run longer if time permitted.

United Aircraft Corporation, Research Department

Average error-free running period	2 hours
Good time	2,667 hours
Attempted to run time	3,473 hours
Operating ratio (Good/Attempted to run)	0.77
Figures based on period	1 February 1956 to 30 September 1956
Acceptance test	5 October 1953

Attempted to run time includes calculation, check-out, machine error, unscheduled maintenance, and scheduled maintenance time. The scheduled maintenance for the above period was 367.96 hours and the unscheduled maintenance was 290.75 these two figures should be subtracted from the above "Attempted to Run" figure.

FUTURE PLANS

Government Sample

U. S. Naval Ordnance Test Station, China Lake

A modification has been made to the system to allow asynchronous digital data to fill the entire storage unit at one time. Such data are fed from magnetic tape containing the digitized version of analog information originating at the test equipment. The analog to digital conversion is done as a separate step, prior to entering the data into the computer.

Industrial Sample

Douglas Aircraft Company, Incorporated

System to be replaced by an IBM Type 704 system in May 1957.

INSTALLATIONS

Government Sample

U. S. Naval Ordnance Test Station
China Lake, California

United States Weather Bureau
Washington, D. C.

Industrial Sample

Boeing Aircraft
Wichita, Kansas

Douglas Aircraft Company, Incorporated
El Segundo, California

General Motors Corporation
Detroit, Michigan

Glenn L. Martin Company
Baltimore 3, Maryland

Lockheed Aircraft Corporation
Burbank, California

United Aircraft Corporation
East Hartford 6, Connecticut

University of California
Radiation Laboratory
Berkeley 4, California

ADDITIONAL FEATURES AND REMARKS

Manufacturer

The following pertains to the first picture (at the beginning of this system description)

In the center of the installation shown here, is the Electronic Analytical Control Unit, and at its right is a Card Reader. Behind the control unit is the Power Distribution Unit. On the left are the Magnetic Drum Storage Unit and the Electrostatic Storage Unit. In the group at the right are two Magnetic Tape Readers and Recorders, the Alphabetical and Numerical Printer and the Card Punch. Two Power Supply Units are not visible.
Overlooking the installation is a glass-enclosed conference room.

Government Sample

U. S. Naval Ordnance Test Station, China Lake

Subroutines are available for most appl cations. There are several general purpose programs. System uses the PACT-I Compiler.

Industrial Sample

General Motors Corporation

Two interpretive systems are used, Speed Co and ACOM. Speed Co 3-address while ACOM is 2-address. Both provide for floating point arithmetic, transcendental functions, In-Out operations, B-boxes, and tracing all of which aid in coding and checkout.

Lockheed Aircraft Corporation

A general purpose system called FLOP, a contraction of Floating Octal Point, was developed at Lockheed by members of the Digital Computing Staff.
Flop converts the 701 into an entirely different machine, one which performs all its operations in a "floating octal system, but also permits all the n normal 701 operations to be executed in fixed binary. The floating octal operations performed by the system are add, subtract, multiply, divide (all with real or complex numbers), $\log_8 x$, 8^x, sin x, $\sin^{-1}x$, and square root. The system also provides certain logical operations and control of the input-output devices in three number systems: binary, octal, and floating decimal.
This system was developed in order to obtain a minimum of elapsed time from when a new problem first enters the department to when answers are obtainable.